

# EFFECTS OF CATTLE GRAZING ON BIRD ASSEMBLAGE AND DIVERSITY IN THE PALO VERDE MARSH

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**Abstract:** Cattle grazing in the wetland of Palo Verde National Park, Costa Rica was reintroduced in 1986 in an attempt to reduce the dominance of cattails (*Typha dominguensis*) and restore bird diversity in the marsh. We examined the effectiveness of this management by surveying avian communities in three marsh sites that were formerly grazed, are currently moderately grazed, or are currently heavily grazed. Avian species richness was highest in moderately grazed site (17 species), followed by heavily grazed site (15 species), and formerly grazed site (12 species). Species diversity was lower in the formerly grazed site than in either moderately or heavily grazed site ( $H' = 0.66, 0.92, \text{ and } 0.88$ , respectively). The formerly grazed site contained higher vegetation and was occupied mostly by birds that forage on aerial insects, while moderately and heavily grazed sites contained shorter vegetation and were utilized by species that forage more on aquatic prey. Cattle grazing appears to promote the maintenance of an open marsh ecosystem at Palo Verde that supports a relatively high diversity of aquatic bird species.

**Keywords:** avian community structure, management, species diversity, species richness, tropical wetlands

## INTRODUCTION

The marsh at Palo Verde National Park, Costa Rica is a valuable habitat for over 60 species of resident and migratory water birds (McCoy and Rodríguez 1994). Palo Verde, which became part of the National Park System in 1980, was originally a privately owned ranch. From 1923 to 1981, between 10,000 and 15,000 head of cattle grazed in the  $\approx 4,750$  ha ranch during the dry season, often creating large portions of open water by trampling the marsh vegetation. Cattle grazing was eliminated from the park in 1981. By 1988, 95% of the marsh was covered by cattails, *Typha dominguensis* (McCoy and Rodríguez 1994). This development of a nearly monospecific stand corresponded with a decrease in the diversity of other plant species (Abram et al. 1994). The avian community may have been similarly impacted, although the specific effects are unknown.

To alleviate the undesirable effects of cattails, cattle grazing has been slowly reintroduced to the park since 1986, in conjunc-

tion with studies of other cattail-eradication techniques. There are currently three levels of grazing land in the Palo Verde marsh: formerly grazed, moderately grazed, and heavily grazed (E. Gonzalez, pers. com.). In this study, we evaluated the consequences of grazing management for bird species associated with the marsh.

We hypothesized that cattle grazing affects avian species diversity, and predicted that moderate grazing intensity would increase bird species diversity as it seems to have increased plant species diversity, perhaps as a consequence of this increased plant diversity. To test this hypothesis, we examined the relative abundance and community composition of the avian community in three areas of the marsh, each with a different grazing intensity.

## METHODS

We surveyed three marsh sites that have been exposed to varying levels of cattle grazing in the Palo Verde National Park, Costa

Rica near the OTS biological station. One of the three sites, 200 m east of the fire tower, had not been grazed within the past 2 years (formerly grazed), one, at the fire tower, is currently being moderately grazed (approximately 200 head of cattle/km shoreline for the past 6 years) and one, 2 km west of the station on the road, in front of the hacienda, is currently being heavily grazed (800 head of cattle/km shoreline for the past 6 years, E. Gonzalez, pers. com.). The vegetation height at each site was visually quantified as: high ( $\approx 2$  m, e.g. areas dominated by cattails, *Typha dominguensis*), medium ( $\approx 1$  m, e.g. areas dominated by the grass, *Hymanachina amplexica*) or low ( $\approx 0.5$  m, e.g., areas of low vegetation containing water lilies, *Nymphaeae sp.*, water hyacinth, *Eichamie sp.* and often some open water).

In addition, we calculated the Shannon Diversity Index and the Shannon Evenness Index for each site. The diversity indices were compared among plots with a t-test as described by Zar (1984).

## RESULTS

Vegetation in the moderately and heavily grazed sites was dominated by medium height grasses, and also contained areas of low vegetation (water lily and water hyacinth habitat) and open water. The formerly grazed site was dominated by cattail vegetation, and lacked any low vegetation and open water habitat (Table 1).

We observed 12 species of birds in the formerly grazed areas, 17 in moderately grazed areas, and 15 in heavily grazed areas.

Table 1. Visual estimates of percent cover of vegetation height in three marsh sites exposed to varying levels of cattle grazing: formerly grazed, moderately grazed and heavily grazed.

Vegetation Height	Formerly Grazed	Moderately Grazed	Heavily Grazed
High	66	23	20
Medium	34	52	68
Low	0	25	12

At each site we surveyed birds in two plots ( $\approx 75 \times 75$  m each) located adjacent to the shoreline. We sampled at the moderately and heavily grazed sites from 08:00-11:30 and 15:00-18:00 on 13 - 14 January 2000 and at the formerly grazed site from 15:00-18:00 on 14 January 2000. In pairs, we conducted five 15-min surveys at each plot, during which we recorded the species and abundance of all birds occupying, leaving, or entering. We allowed a 15 min period for bird habituation to the observers before beginning each survey.

We summed the abundance of all bird species observed on the two replicate plots for each site. Species richness was measured as the total number of species found per site. In

Species diversity ( $H' \pm SE$ ) of the three areas were  $0.66 \pm 0.030$ ,  $0.92 \pm 0.026$  and  $0.88 \pm 0.035$ , respectively. Diversity was significantly lower in the formerly grazed site than in either moderately grazed or heavily grazed sites ( $t = 6.55$ ,  $df = 524$ ,  $p < 0.001$ ;  $t = 4.70$ ,  $df = 420$ ,  $p < 0.001$ , respectively; Fig. 1). Heavily and moderately grazed sites did not differ in diversity ( $t = 1.05$ ,  $df = 397$ ,  $0.2 < p < 0.5$ ). Similarly, species evenness ( $J$ ) was higher in moderately (0.75) and heavily (0.74) grazed sites than in the formerly grazed site (0.61). Compared to the currently grazed sites, the formerly grazed site tended to support a bird community that was numerically dominated by fewer species (Table 2).

Species composition of marsh birds

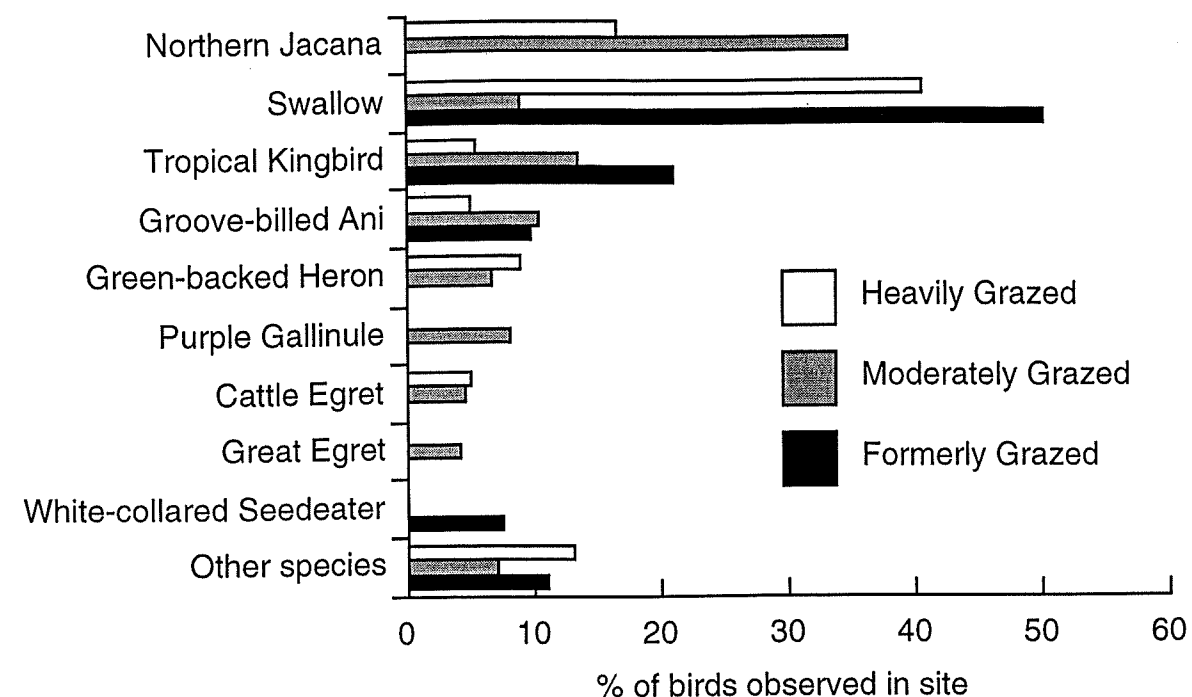


Figure 1. Relative abundance (as percent of observed birds) of species in formerly, moderately, and heavily grazed marsh habitat. Species constituting less than 4% of total were categorized as *Other species*, which included 8 species in ungrazed sites, 9 in moderately grazed and 9 in heavily grazed.

Table 2. Bird species observed at the formerly grazed, moderately grazed and heavily grazed sites in the Palo Verde marsh, Costa Rica: # = number of birds observed and FG = foraging guild (t=terrestrial insectivore; a=aquatic prey; g=granivore; n=nectivore).

FORMERLY GRAZED	#, FG	MODERATELY GRAZED	#, FG	HEAVILY GRAZED	#, FG
Swallow *	131, t	Swallow *	25, t	Swallow *	80, t
Tropical Kingbird**	55, t	Tropical Kingbird	38, t	Tropical Kingbird	11, t
Groove-billed Ani	26, t	Groove-billed Ani	29, t	Groove-billed Ani	10, t
Great Egret	3, a	Great Egret	12, a	Great Egret	7, a
Collared Seedeater	20, g	Northern Jacana	33, a	Northern Jacana	97, a
Red-winged Blackbird	9, t	Purple Gallinule	23, a	Purple Gallinule	2, a
Streaked-backed Oriole	7, t	Green-backed Heron	18, a	Green-backed Heron	19, a
Scissor-tailed Flycatcher	3, t	Cattle Egret	10, a	Cattle Egret	13, a
Cinnamon Hummingbird	2, n	Great Kiskadee	7, t	Great Kiskadee	5, t
Northern Jacana	1, a	Limpkin	4, a	Limpkin	2, a
Green-backed Heron	1, a	Bare-throated Tiger-Heron	4, a	Bare-throated Tiger-Heron	1, a
		Collared Seedeater	2, g	Little Blue Heron	6, a
		Red-winged Blackbird	5, t	Muscovy Duck	2, a
		Snail Kite	3, a	White Ibis	1, a
		Anhinga	2, a		
		Great Blue Heron	1, a		
		Ringed Kingfisher	1, a		

\*Could not differentiate between two species: Mangrove Swallow and Barn Swallow.

\*\*See Stiles and Skutch, 1989 for scientific names.

varied most between formerly grazed and currently (both moderately and heavily) grazed areas. Formerly grazed sites were dominated by terrestrial insectivores, while moderately and heavily grazed sites were dominated by species that forage on aquatic prey (Table 2). Northern jacanas and green-backed herons were abundant in the currently grazed sites, but appeared only once each in the formerly grazed site. Exclusive to the currently grazed sites were limpkins, purple gallinules, bare-throated tiger-herons, snail kites, anhingas, great blue herons, ringed kingfishers, muscovy ducks and white ibises. Exclusive to the formerly grazed site were streaked-backed oriole, scissor-tailed flycatchers and cinnamon hummingbirds.

#### DISCUSSION

Cattle grazing in the Palo Verde marsh is associated with a diverse assemblage of aquatic-feeding bird species. Grazing appears to maintain a lower vegetation height and prevent a cattail monoculture (Table 1), and thus promote a greater diversity of avian species through its effects on foraging habitat. The avifauna in the recently grazed sites was dominated by birds that rely on low vegetation, which allows access to aquatic prey (e.g. herons, jacanas, limpkins, egrets), while the bird community of the formerly grazed site was dominated by species that thrive on cattails and occupy nearly terrestrial habitat (e.g. red-winged blackbirds, swallows, seedeaters, orioles). The similarity between avifaunas in the moderately and heavily grazed sites suggests that the intensity of grazing at Palo Verde is not as important as the presence of at least some grazing. However, we note that replication in this study was limited to only two plots per treatment, which did not allow us to assess variation within treatments.

Nonetheless, our results suggest that cattle grazing in Palo Verde National Park

promotes the maintenance of a marsh ecosystem that supports high avian diversity. If the objective of park management is to promote species diversity and to preserve the open marsh ecosystem, then cattle grazing should continue to be used as a management tool at Palo Verde. Important questions about the effects of grazing intensity should be carefully addressed through long term analyses of vegetation structure and species composition.

#### LITERATURE CITED

- Abram, E.H., J.J. Ruel and D.B. Zug Jr. 1994. Examination of current *Typha latifolia* management in a freshwater marsh, Palo Verde, Costa Rica. Pp. 27-29 in J.L. Bykowski, editor, *Dartmouth Studies in Tropical Ecology 1994*. Dartmouth College: Hanover, NH.
- McCoy, M.B. and J.M. Rodríguez, 1994. Cattail (*Typha domingensis*) eradication methods in the restoration of a tropical, seasonal, freshwater marsh. Pp. 469-482 in W.J. Mitsch, editor, *Global Wetlands: Old World and New*. Elsevier Science.
- Stiles, F.G. and A.F. Skutch, 1989. A guide to the birds of Costa Rica. Cornell University Press: Ithaca, NY.
- Zar, J.H. 1984. *Biostatistical analysis*. 2<sup>nd</sup> Edition. Prentice-Hall, Englewood Cliffs, N.J.